DISCUSSION

PUMPING MACHINERY, TEST DUTY VERSUS OPERATING RESULTS[1]

By J. N. Chester

Mr. J. N. Chester: After having written the paper, in the preparation for the cross-examination which he expected might come after its reading, the author went to the expense of sending a man around the country to get some results, which results when obtained tended to weaken his faith in the statement that the steam turbine, as a power producer has made in the past five years more rapid strides in economy than any other type of steam motor, and many of us will live to see it almost entirely supplant the reciprocating engine. The author does not like to use a turbine under 250 to 300 h. p. Mr. West of the Bethlehem Company has given permission to quote him as saying that in that last statement he was in error, that instead of the vertical triple being crowded off the map by the turbine-driven centrifugal, it would be pushed the hardest by the internal combustion engine driving some type of pump. That of course takes us back, we might say, to the field of that type of unit. The author has limited it to one million gallons, and is using it in several plants of a much greater capacity, but in the natural gas fields. If this paper could go further as to all conditions we might considerably broaden the use of the gas engine. The author is not partial to the gas producer gas engine driven plant, except for some remote conditions, and it must be realized that, as stated in the paper, there are many things that may change the curves so as to show different results. The results depend as much upon the man as upon the machinery.

President Hill: The chair does not know of any particular feature of the average water works plant where so complete a lack of knowledge of the fundamentals of design is manifest as in the pumping station.

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MR. W. F. WILCOX: There are so many factors that enter into the proper designing and operation of a pumping station that it would be difficult to undertake to discuss all of them; the speaker will not even undertake to discuss the theoretical determinations arrived at; but will make a few remarks which may be of some benefit to the man who wants to improve pumping station conditions without getting all muddled up; but the speaker can say a few things to you with safety. One is that the greatest loss in the operation of a pumping plant is due to the fact that it is considered as a whole when it should be considered under its several different heads.

The first and most important danger is the lack of conception by those using it that the steam engine is a heat engine. They think that the steam runs the engine like water runs a water wheel; but that is not the fact, because although the steam pressures may be equal, the efficiency obtained will vary in relation to the heat. Therefore, the most valuable instruments which any man can use in a steam plant are a U tube and a thermometer. With those two instruments one can come nearer getting at the disease with which the plant is afflicted, and explaining the remedy to the operating engineers and firemen than by any other known means. When installing or testing a new engine, put thermometers in the pipes where the steam enters and leaves the engine, the controlling points, and thus ascertain the heat that has been used between those two points in the test, this being the utmost which can be approached in every-day operation.

The plant may not be large enough to have all the appliances for testing gauges, and operators must have the "knack." Many men have not the "knack," and that is the reason they do not succeed in life. The same thing applies to a pumping station.

The thermometer is one of the most valuable controls, because the engine is absolutely a heat engine. If you will, when you go home, look your pumping station over and determine by the use of thermometers the best heat results that you can get in the operation of the engine, then determine what your load factor is on that engine, you will find that the load factor will vary the economy from day to day. The reason that operating statistics do not conform to test conditions is that the load factor varies all the time in water works; that is more nearly true of a plant under 5,000,000 gallons daily capacity than with a plant of greater capacity.

Assuming that pumping plants are properly designed, if you will check your engine by a thermometer and by your load factor you can determine what is the best daily result that you ought to be able to attain. Separate your engine and boiler accounts, no matter how small your plant is. The speaker has tried CO_2 recorders, pyrometers, and many other instruments and they get firemen so mixed up that they do not know where they are at. Put an ordinary U tube on the furnace, and you can show your fireman how to keep his fires in good shape, you can show him how to regulate the draft; and you can come nearer developing your fireman into practical usefulness than by any other plan, unless you have a scientific man on your boiler plant all the time.

The speaker had a scientific man at the pumping plant, but to educate the men he had to use a U tube, which costs about fifteen cents. There are some good old rules of thumb that are right handy to have on your desk, rules of thumb that experts laugh at, but if they will figure them out they will find that they are not far away from the best scientific practice. Take the number of B. t. u. in the coal, multiply by 6, point off four figures, and you will get approximately your evaporation; for example, take 13,000 B. t. u., multiply it by 6, that gives you 78,000. Point off four figures and you have 7.8. Now with 13,000 B. t. u. coal, 7.8 is a pretty good result.

A good many people think they are getting a uniform temperature of 200° F., and they are at the time they look at the thermometer. A recording thermometer, costing about $50, will show the temperature at all times, and will prove a good investment.

The actual cost of operation every year ought to be about uniform in any plant. The cost of boiler h. p. generation varies according to the coal cost. In a plant of 500 h. p. you ought to get a cost of operation inclusive of fuel of $2 per h. p. In a plant of 100 h. p. to 200 h. p. if you run as high as $3 it is not excessive. You have to use 500 h. p. to obtain the $2 figure. With a 1000 h. p. plant you ought to get the cost down to about $1.50, or a little less; when you get up to 2000 h. p. you ought to get the cost down below $1; when you get up to 10,000 h. p. you ought to get it down to about 50 cts.

If you will take these little suggestions, or "rules of thumb" and apply them in the daily watching of your boiler plant they will indicate the points which must be followed up, and you can follow them up as closely as you wish.

Mr. Chester spoke of the friction in the steam pipe. There is nothing that is worse confounded than friction in a steam pipe. The modern practice is to increase your velocities. A great many people seem to think that steam pipes are too small. If the velocity in your steam pipe is for ordinary saturated steam 3000 feet, you will have a very good velocity. Getting up into super-heated steam, you can go up into 6,000 or 10,000 feet.

The pipe covering is a very valuable asset, and should be carefully attended to. But go back to that old thermometer, stick it into the pipe again and it will tell you what the temperature ought to be.

MR. JOHN W. ALVORD: Every year we have a valuable paper from Mr. Chester, and he gets more and more mellow, and less and less exact in his statements, which to the speaker's mind is a great advantage. He has presented us some very valuable prospectives, if they might be called so, with regard to station economy; but his characterization of the pump salesman was particularly enjoyed, it was a reminder of the days when he used to sell pumps.

MR. ALLEN HAZEN: This is one of the best papers ever presented to this Association. It is difficult to understand why the author stopped with pumps. The conditions that are so well described relating to the sale of pumps exist equally for other kinds of equipment.

MR. H. G. H. TARR: Mr. Chester's valuable paper brings up many memories. He was one of the speaker's assistants in the pump selling business.

However, listening to his learned paper is like sitting at the feet of Gamaliel. The speaker often looks with great pride to the boys that have graduated under him, for instance, Foster, of super-heater fame; Primrose and Nutting, his able associates; Swanhausser, Chief Engineer of the International Pump Co.; Webster of Babcock & Wilcox, and many more of them, who have made their mark in the engineering world.

It is curious how much more respect one has for John Chester when bidding on his specifications for a Pumping Engine, than he had for him as a young engineer, promising as he was.

Having been in this game for a long time, the realization grows

stronger with the years that engineering is simply tying up good practice with a dollar.

As an illustration, a New York banker wanted an engineer for a certain piece of work, and it was very important that he should get one competent and experienced. The speaker asked him smilingly, "Why don't you employ So-and-So?" He replied, "Why don't I? Why he knows no more of the relation between engineering and the dollar than my boy ten years old." There was a new thought; and when conducting engineering enterprises try to keep it in mind, and constantly hitch up that relation between engineering and the dollar. Is it not true of water works engines, stationary engines, in fact, all the great economic enterprises, that you must hitch up the relation between engineering and the dollar? And there is no example in the world where it is so forgotten and ignored as in the relation between the boiler and engine.

Thermometers, and that kind of thing, of course, are essential, but don't forget the human element, especially in your pumping station. The speaker has gone lots of times into engine houses where he did not want to criticise, because he wanted them to keep their engines in especially good order, and they would tell with great pride what they were doing, on an assumed evaporation; then in the boiler room he had seen them chucking in the coal, paying no attention whatever to economy of the boiler. In many cases, the engineer of the old days seldom went into his boiler room.

Here is a trade secret; a pumping engine builder employed a man by the year, and gave him good pay, whether he worked or loafed, and that man always did the firing on every test made of that builder's engines. The rest of the time he was supposed to sweep out the shop, but he did very little sweeping. That man could go into an engine room on a test and get ten per cent more out of a boiler than any other man the speaker ever saw. How did he do it? He had the "knack." He was originally an old steamship fireman, and that is where he got on to the "knack," firing on a steamship where at the end of the voyage they gave the fireman a bonus on coal saving. Would not this be a good idea in a water works station? Watch your firemen, and give them some incentive. Train your men so that they will watch every ounce of coal that they put into the furnace, and it will do more good than thermometers. Not condemning by any means scientific efficiency, the speaker has found, after long years of experience, that the best results are obtained in the handling of a

pumping plant through careful watching of the performance of the human element.

It is admirable and essential that your men should keep the engine bright, essential that they watch the steam consumption and those details, for that is part of the efficiency of this same human element and so, have your engineer, your fireman, your wiper—every man fall in and see to it that individually the best results are obtained.

MR. HARRY ELLSWORTH: This paper appeals to the speaker very strongly, as it should to every man who has the responsibility of the operation of a water plant. There has been a growing demand here for more papers of a practical nature; and Mr. Chester's papers always possess that characteristic.

The speaker has been attending these conventions for a number of years, and during that time has heard a good many papers read quoting station duties of from 125 to 150 million foot pounds, in small and moderate sized stations. When hearing those papers read, he commenced to think he was not doing his full duty; so this paper comes as a relief to his mind. Our station is a small one. We have one pump of 4,000,000 gallons daily capacity. The contract duty on which was 140 million foot pounds. This pump has all the refinements that tend toward efficiency, triple expansion, live steam jackets, high duty compensating cylinders, etc., and on test it did develop a duty in excess of the contract duty, considerably in excess of it, a duty, of course, based on 1000 pounds of steam, yet it has failed in maintaining this duty in every-day operation. The results have been disappointing in that respect. It was not long before we found that there was a wide difference between actual every-day operating conditions and the conditions under test. The first thing that the speaker discovered was that a steady steam pressure is conducive to high efficiency. He also learned that the handing to the fireman of a five dollar bill was conducive to a steady steam pressure, this course being perfectly justifiable on the part of the man who was making the test, but we cannot afford to do that under every-day operating conditions.

From another pump the contract duty of which was 100 million foot pounds under every-day working conditions we are getting a duty of 50 million foot pounds per hundred pounds of coal. From his experience the speaker feels that if we get an every-day station duty of one-half of the contract duty we should be satisfied.

MR. DABNEY H. MAURY: Of course we have all enjoyed exceedingly listening to Mr. Chester. He is always a treat. In this particular thing he is of course almost at his best, because he is talking on a subject that he thoroughly knows and in which he takes a keen interest. Mr. Chester is a man after the speaker's own heart, in that, while we will not go so far as to say that he seeks a scrap, yet he prepares carefully for a scrap; and would know a scrap if he saw it coming down the road, and would be pretty nearly ready to meet it.

When in the tropics the speaker learned for the first time why a dog had a tail; he never knew just why a dog had a tail; had considered it a sort of belated smile which finally started on the other end; but did not quite see any really useful purpose in the dog's tail. Down there, going out with some old hunters to look for tapirs and other wild animals, which we did not get, he was told that the reason the dog had his tail was that he could feel around behind him and find a place to back out when the enemy charged upon him. Now Mr. Chester's qualifying comment on his prophecy as to the turbine has shown that he is fully equipped in that regard. We must endorse that as we do all his other statements.

MR. SAMUEL B. APPLEBAUM: The speaker will make a few remarks which will interest the members regarding one source of loss of heat between the boiler and the pumping engine which Mr. Chester has not mentioned. The loss due to the scale in the boilers is referred to, having in mind a particular pumping station in Springfield, Ohio, where surface condensers are returning to the boilers from 80 to 90 per cent of all the steam evaporated. The 10 to 20 per cent of raw make-up water was sufficient to cause a heavy scale in the boilers. Of course, no one knew exactly how much loss of heat that scale was responsible for. It was only after a water softening plant was put in and a test made of the apparatus for a few months, that it was possible to determine the great reduction in the cost of pumping which resulted from the elimination of scale. The water softening plant has now been in operation over one year; and a test was run for the months of March and April, 1916, comparing the coal burned on the grates with that which was burned during the same two months of the year previous. It was found that about 20 per cent of the coal was saved by softening the water and eliminating the scale. There were no other factors, such as load factor, etc., to be taken into consideration because the amount of water pumped

was the same within 2 per cent during both periods compared, and the grade of coal and labor were the same in both runs, thus eliminating all the various factors that have been brought up that might be of influence.

The duty of the pumping engines based on 100 pounds of coal increased from 60 million foot pounds in 1915 to 80 million foot pounds in 1916. The cost of pumping was therefore reduced about 20 per cent by the installation of the Water Softening Filter.

MR. J. N. CHESTER: Just one remark in reply to the comments of Mr. Wilcox, who said that thermometers will tell you the losses in the steam pipe. If the steam is not super-heated, unless the pressure drops in the line, there will be no drop in temperature regardless of what your condensation or heat loss may be.